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INSTRUCTION MANUAL FOR

MODEL No. 230-5

FORMERLY MODEL 209

SERIAL No. 647/3179

BETA ELECTRIC CORP.
NEW YORK, N. Y.

McCarthy Associates
Ryan 18810

NOTE:

Please read the entire instruction manual thoroughly before attempting to operate the unit.

If this is not convenient, please read the operating instructions completely before applying power for the first time.

DS/hk - 4/10/57

Instruction Manual ADDENDA
for
Series 200 Power Supplies -A-

βeta Electric
Div. of Sorensen & Co.,Inc.
New York 29, New York

The Operating Instructions and Service Notes for the Series 201 Power Supplies apply for the new 200 Series Portable High Voltage DC Power Supplies.

The following instruction manual addenda lists any modifications or additions to be made to the booklet.

A parts list addenda and a point-to-point wiring diagram are also included.

PAGE #	ITEM #	REVISION
1	I(2)	OUTPUT CURRENT: 2.0 ma at 30 kv, 3 ma below 28 kv (Model 230-2). 5 ma at 30 kv, 7 ma below 24 kv (Model 230-5).
1	II(2)	Single range covat output current meter: 0-1 ampere ac for 230-2. 0-3 amperes ac for 230-5.
1	III	Special Features are combined as R&D (Research & Development) features, and include: (1) -F FINE CONTROL of output voltage to approximately 0.05% of maximum. (2) -M2 LOAD CURRENT METER, dual range; scale ratio 10:1. (3) -OL1 OVERLOAD RELAY, adjustable trip; 30-110% of maximum rated current (Model 230-2), 12-110% (Model 230-5). (4) -V2 OUTPUT VOLTAGE METER, dual range, scale ratio 3:1. /R Relay rack mounting construction, standard 19" width, 19" panel height, 9-1/2" deep. This feature available for all 200 Series Units, and is supplied only when specified.
2	INPUT VOLTAGE	105-125 volts, 50-60 cycles ac; 1.5 amperes at maximum output voltage and rated current (Model 230-2), 3 amperes (Model 230-5). 400 voltamperes maximum.
2	OUTPUT CURRENT	2.0 ma at 30 kv, 3 ma below 28 kv (Model 230-2). 5 ma at 30 kv, 7 ma below 24 kv (Model 230-5).
2	POLARITY	REVERSIBLE high voltage polarity (low grounded); (for all 200 Series Models).
2	REGULATION	Internal resistance: 2.5 megohms.
2	RIPPLE	Approximately 1.0% per ma at 30 kv.
2	METERS	I: STANDARD DESIGNS: (2) 0-1 AMPERES AC (Model 230-2). 0-3 AMPERES AC (Model 230-5). II: SPECIAL DESIGNS: -M2: 0-1/10 MILLIAMPERES DC (Model 230-5R&D)

βeta Electric
Div. of Sorensen & Co.,Inc.
New York 29, New York

PAGE #	ITEM #	REVISION
2	CONTROLS	#6 - (ON ALL MODELS)
3		#8 - -M2 or 0-1/10 MILLIAMPERES
3	FUSE PROTEC-TION	#1 - MAIN LINE - 4 amperes for 230-5 and 230-5R&D.
		#2 - COVAT OUTPUT - 3 amperes slo-blo for Model 230-5.
3-11		The GENERAL discussion, the CIRCUIT DETAILS, the OPERATING INSTRUCTIONS, the APPLICATION NOTES and the SERVICE NOTES, apply for the Series 200 Power Supplies. The parts listed on pages 12 - 15 are modified by a parts list addenda sheet.
		DRAWINGS:
		Figure 2: This diagram applies for Models 230-2 and 230-5.
		Figure 3: This schematic refers to Models 230-2R&D and 230-5R&D. Note that the current range given is for the 230-2R&D.
		For Model 230-5R&D, the ranges are "1" and "10" FULL SCALE MILLIAMPERES.
		Figure 4: This curve applies for Model 230-2R&D and a supplementary curve is attached for 230-5R&D.
		Figure 5: The parts placement as modified is applicable for the 200 Series units.

OPERATING INSTRUCTIONS

AND

SERVICE NOTES

for

SERIES 201

PORTABLE HIGH VOLTAGE DC POWER SUPPLIES

0 to 30,000 VOLTS DC

* * *

MODELS 201, 202, 203, 204, 205, 206

and F, M1, M2, OL, OL1, /R, V2 designs

BETA ELECTRIC CORP.

333 EAST 103rd STREET

New York 29, New York

Designers and custom builders of High Voltage Power Supplies AC and DC; Insulation and "Hipot" Testers; Kilovoltmeters; Electronic Rheostats; Portable Projection Oscilloscopes; Electronic Microammeters and Industrial Electronic Equipment.

August 1955

WARRANTY

This power supply is guaranteed against all defects of workmanship or material, with the exception of rectifier tubes, (on which no guarantee is given) for a period of 1 year after date of shipment,

PROVIDED that the guarantee card for the power supply, sent with the unit, has been properly filled out and returned to us, and that the unit has not been mechanically abused, nor operated beyond its electrical ratings.

For units requiring service after the warranty period, the power supply may be returned to the factory without prior authorization. Repairs will be made at nominal charges for parts and labor.

SERIES 201 DC POWER SUPPLIES' GENERAL CHARACTERISTICS

I: ALL the βeta Electric Corp. SERIES 201 Power Supplies have the following basic features in common, no matter what the specific Model number may be:

(1) OUTPUT VOLTAGE: 0-30,000 volts dc, continuously variable.

(2) OUTPUT CURRENT: 2 milliamperes dc maximum average load current.

(3) SIZE: 16″ wide x 16″ high x 9″ deep (except for /R, rack mounted models.)

(4) WEIGHT:40 pounds, (Except for /R, rack mounted models, which are 45 pounds.)

(5) FINISH:Gray hammertone.

(6) Certain control and auxiliary features listed in the SPECIFICATIONS section.

II: The STANDARD designs have the following features:

(1) Single range output voltage meter, 0-30 kilovolts dc.

(2) Single range covat* output current meter, 0-1 ampere ac.

(3) High voltage transformer primary fused, but NO overload relay.

III: The following SPECIAL features are available:

(1) -F: fine output voltage control, to within 0.05% of maximum output voltage, or 15 volts, over entire output range. (Recommended, only for use with -V2 designs; also, line voltage regulator should be employed.)

AND/OR

(2a) -M1: single range load current meter, 0-2,000 microamperes dc, replacing the covat* output current meter (II,2).

OR

(2b) -M2: dual range load current meter, 0-200/2,000 microamperes dc, replacing the covat output current meter (II,2).

AND/OR

(3a) -OL: fixed overload relay protection, tripping at approximately 2.0 milliamperes dc.

OR

(3b) -OL1: adjustable overload relay protection; tripping at approximately 0.6-2.0 milliamperes dc.

AND/OR

(4) -/R: relay rack mounting construction, standard 19″ width, 19″ panel height, 9½″ deep.

AND/OR

(5) -V2: dual range output voltage meter, 0-10/30 kilovolts dc.

* COVAT — COntinuously Variable Auto Transformer; i.e., powerstat, variac, etc.

SPECIFICATIONS

for Models 201 through 206, standard, and with special features

Portable 0-30 KV DC Power Supplies

* * * * *

INPUT (ALL MODELS)

100-130 volts (117 volts nominal), 50/60 cycles, 200 voltamperes, maximum.

* * * * *

OUTPUT (ALL MODELS)

Voltage: Continuously variable from 0 to 30,000 volts dc.

Current: 2 milliamperes maximum (determined by rectifier rating).

Models 201, 202 and 203 -- Approximately 400 microamperes at 30 kv.

Models 204, 205 and 206 -- Approximately 1.8 milliamperes at 30 kv.

Polarity: Models 201, 204 -- High voltage positive (negative grounded).
Models 202, 205 -- High voltage negative (positive grounded).
Models 203, 206 -- Reversible high voltage polarity (low grounded).
(NOTE: Ground refers to power supply cabinet.)

Regulation: Models 201, 202, 203 -- Internal resistance approximately 3.5 megohms. (Not stabilized against line voltage variations.)
Models 204, 205, 206 -- Internal resistance approximately 2.5 megohms. (Not stabilized against line voltage variations.)

Ripple: (60 Cycle Input)
0.3% with external load of 1000 megohms.
0.6% with external load of 100 megohms.
3% with external load of 10 megohms.
25% with external load of 1 megohm.

Filter Capacitance: 0.005 mfd. in series with $\frac{1}{2}$ megohm protective resistance, in parallel with high voltage output cable capacitance (150 mmf., approx.) and in parallel with load capacitance (if any).

METERING AND AUXILIARY CIRCUIT FEATURES

I: STANDARD DESIGNS:

Meters:

(1) OUTPUT VOLTAGE; 0-30 KILOVOLTS DC; 2-$\frac{1}{2}$" round case; initial accuracy 2.5%.

(2) COVAT* CURRENT; 0-1 AMPERE AC; 2$\frac{1}{2}$" round case; 3% accuracy.

II: SPECIAL DESIGNS:

-V2: OUTPUT VOLTAGE: 0-10/30 KILOVOLTS DC; 2-$\frac{1}{2}$" round case; initial accuracy 2.5% on each range.

-M1: LOAD CURRENT: 0-2 MILLIAMPERES DC; 2-$\frac{1}{2}$" round case; 3% initial accuracy.

-M2: LOAD CURRENT: 0-200/2000 MICROAMPERES DC; 2-$\frac{1}{2}$" round case; 3% initial accuracy on each range.

Controls: I: ON ALL DESIGNS:

1. - FILAMENTS ON toggle switch.
2. - HIGH VOLTAGE HOLD push-button.
3. - HIGH VOLTAGE LOCK push-button.
4. - HIGH VOLTAGE OFF push-button.
5. - OUTPUT VOLTAGE CONTROL covat.
6. - (Models 203 and 206 only) DC METER POLARITY SELECTOR switch.

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*COVAT — COntinuously Variable Auto Transformer; i.e., Powerstat, variac, etc.

II: FOR SPECIAL DESIGNS:

7. - -F designs: FINE OUTPUT VOLTAGE CONTROL rheostat.
8. - -M2 designs: Load current meter range selector, "200-2000 MICROAMPERES," rotary snap switch.
9. - OL designs: OVERLOAD RESET pushbutton.
10. - -OL1 designs: OVERLOAD TRIP CURRENT rheostat.
11. - -V2 designs: Output voltage meter range selector switch.

Pilot Lights:

I: ON ALL DESIGNS:

1. - FILAMENTS ON clear neon pilot light.
2. - HIGH VOLTAGE ON red neon pilot light.

II: FOR OL, OL1 DESIGNS ONLY:

3. - Clear neon pilot light to indicate OVERLOAD.

Fuse Protection:

1. - MAIN LINE: 2 amperes.
2. - *COVAT OUTPUT: 1 ampere "Slo-blo"

Size:

I: STANDARD DESIGNS:

Cabinet - 16" high x 16" wide x 9" deep. Add 2" height for carrying handle, 1-$\frac{1}{2}$" depth for control knobs, 3/4" width for ground post.

II: /R DESIGNS:

relay rack panel mounted (Model /R); Panel 19-1/4" x 19" high, depth behind panel 9-$\frac{1}{2}$".

Weight:

I: STANDARD DESIGNS:

40 pounds.

II: /R DESIGNS:

46 pounds.

Auxiliary Feature:

An auxiliary 2-pronged outlet is provided in parallel with the input plug. (This may be rewired for an interlock or an external shorting mechanism. See Application Notes 3 and 4, page 9).

Connections:

(1) INPUT POWER - 2-pronged recessed male receptacle, 125 volts, 10 amperes; suitable 6' line cord provided with the power supply.
(2) OUTPUT POWER -
(a) High Voltage: A 6' long polyethylene insulated, shielded cable, with a rubber covered battery clip, (permanently connected) exiting from left rear bottom of cabinet (as viewed from rear).
(b) Low Voltage: Binding post connected to case.

GENERAL:

The βeta Electric Corp. Series 201 Portable 0 to 30,000 Volts DC Power Supplies, utilizing rectified 50 or 60 cycle power, are compact, air insulated, extremely reliable power supplies, (they are now in their 10th year of industrial use) specifically designed for low-current, high-voltage applications. Approximately 500 microamperes may be drawn at 30 kv from Models 201, 202 and 203 power supplies, and 1.8 ma at 30 kv in the 204, 205, 206 models.

The maximum permissible drain, as determined by the rectifiers' rating, is 2 milliamperes average, being available below approximately 24 kv in the Models 201, 202, and 203, and approximately 28 kv in the Models 204, 205 and 206. All other circuit components are conservatively rated for considerably more than 2 ma load or 30 kv output voltage.

The power supplies are complete instruments, designed for rugged industrial use, including continuous operation at maximum rated output voltage and current, and for exacting research work. Such important features, as dual pushbuttons for permanent high voltage switching, are indicative of the safe design for use by untrained personnel on a factory production line. The use of a "holding relay" for the high voltage primary power precludes the possibility of damage to electrical components undergoing life tests, if the line power should fail momentarily and then return, when the equipment is unattended.

These power supplies employ a full-wave voltage-doubler circuut, permitting the use of components considerably lower in voltage rating than required in a full-wave or half-wave single-stage rectifier of equivalent voltage output. The high voltage transformer is rated at 11.5 kv rms, and the rectifiers are subjected to an inverse voltage approximately equal to the actual output voltage. Thus, with rectifiers rated at 40 to 60 kv inverse, there is an ample margin of safety at an output voltage of 30 kv. (40 kv rating in Models 201, 202 and 203; 60 kv rating in Models 204, 205 and 206.)

The high voltage filter capacitors contain plastic dielectric materials of high breakdown rating, reducing the size and weight considerably over capacitors of the same rating utilizing paper or similar dielectric materials.

*COVAT - see note, pg. 1

A unique filament transformer design, developed by the βeta Electric Corp., results in a lightweight, air insulated unit with filament windings rated for more than 40 kv dc insulation with respect to the core and to the other windings. Without this lightweight, multi-winding high voltage filament transformer a low cost portable, rectified 60 cycle, 0 to 30 kv dc power supply would not be practical with air insulation.

In the Models 201 to 206 power supplies, the output dc voltage is metered, as is the covat* output current. This latter meter is valuable as a general purpose, trouble-shooting device. The ammeter will indicate whether there are any shorts in the power supply or in the load circuit, by reading off-scale with only a few volts output from the covat. The meter will read lower than normal in case of open circuit.

In the Models 201 and 204, the high voltage dc polarity is fixed, positive with respect to the cabinet (ground). In the Models 202 and 205, the high voltage dc polarity is fixed, negative with respect to the cabinet. In the Models 203 and 206, the high voltage polarity with respect to the grounded case may be either positive or negative, as desired. Polarity reversal is effected by reversing the sense of rectification of the two rectifier tubes; the positions of two leads inside the power supply are interchanged for this reversal.

For added operating convenience, the control panel has been made removable from the high voltage circuits proper. The panel wiring is connected to the remainder of the circuits through a cable connector pair. When the panel is removed, it is necessary only to run an extension cable of the desired length from the control panel to the high voltage circuits. The extension cable can be well over one hundred feet in length without affecting the operating properties of the power supply.

Several special features are available, to increase the range of usefulness of the Series 201 units, as follows:

-F designs:

The output voltage is adjustable to within 15 volts, over the entire range, or 0.05% of full scale.

-M1 and -M2 designs:

In the series M1 and M2 power supplies, a load current meter is substituted for the covat meter. The load current meter is at ground potential, indicating all leakage and corona current, as well as load currents. -M1 designs employ a single range meter, 2000 microamperes; -M2 designs provide two load current ranges, 200/2000 microamperes.

-OL designs:

An overload relay trips off high voltage power in case the load current exceeds about 1.8 ma. The relay is in the ground end of the rectifier circuit, and responds within 3 cycles in case of load flashover.

-OL1 designs:

The trip current of the overload relay, mentioned above, is adjustable from about 0.6 ma to 1.8 ma, by means of a rheostat on the front of the cabinet.

-V2 designs:

A dual range kilovoltmeter, 0-10/30 kilovolts dc, is provided instead of the single 0-30 kilovolts that is standard.

CIRCUIT DETAILS:

(a) CONTROL CIRCUITS

I: all Models

Referring to the accompanying schematic circuit drawing, Fig. 1, the operation of the control circuits of the power supply can be understood. The basic controls are the same for all models.

J1 is a two-pronged recessed male connector, located on the left-hand side of the cabinet, as viewed from the front, through which the power supply is connected to the nominal 117 volts mains by means of a line cord W1 provided with the power supply.

J2 is an auxiliary 117 volts outlet, located adjacent to the input connector, energized when J1 is energized, that may be used for such equipment as an oscilloscope, soldering iron, etc. It can also be used for an external safety interlock, or for an external output shorting mechanism. (See Application Notes 2 and 3, pages 8 and 9).

F1 is a fuse for general protection.

J3 is a binding post labelled ALWAYS OPERATE WITH GOOD EXTERNAL GROUND located near J1, and connected electrically to the cabinet. This should always be connected to a good external ground before the power supply is plugged into the 117 volts source.

Toggle switch S1 FILAMENTS ON, energizes the filament transformer T2, and pilot light I1. It is seen that the filaments are energized with rated voltage at all times, independent of the output dc voltage.

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* COVAT — COntinuously Variable Auto Transformer; i.e., powerstat, variac, etc.

Depressing S3, the pushbutton labelled HIGH VOLTAGE HOLD, energizes the covat* T1 and, accordingly, the primary of the high voltage transformer T3. When S3 is depressed, the HIGH VOLTAGE ON pilot light, I2 is illuminated. When S3 is released, the covat is de-energized. Thus, S3 must be held depressed for high voltage.

If it is desired to have the high voltage continuously on, then, when S3 is depressed, it is necessary to depress simultaneously pushbutton S4 labelled HIGH VOLTAGE LOCK. This energizes the relay K1, shorting out pushbuttons S3 and S4 by means of two normally open contacts 1a and 1b on the relay K1. The relay is now held in automatically, and the pushbuttons may be released; the high voltage will remain on.

To de-energize the high voltage when it has been "locked in," the red pushbutton labelled HIGH VOLTAGE OFF, S2, must be depressed. This opens up the normally closed switch removing covat power and also causes the relay to drop out, thus opening contacts 1a and 1b.

The "holding relay" K1 ensures permanent removal of high voltage power if the line voltage should fail momentarily. With loss of line power for as short a period as 1 cycle, the relay will drop out, opening contacts 1a and 1b, and removing power from the covat primary.

Meter M1, COVAT CURRENT, monitors the input current to the high voltage transformer T3. In case of a short circuit in the high voltage components or load, M1 will read higher than normal. If a circuit element is open, M1 will read lower than normal. Normal reading is about 0.3 amperes at no load and 30 kv output.

NOTE: The covat current meter M1 is omitted in the -M1 and -M2 designs. A dc load current meter is employed, located as discussed below.

Capacitors C1 and C2 constitute a line filter to reduce feedback of corona-generated rf noise to the power mains from the high voltage circuits.

Fuse F2 protects the high voltage transformer T3, the covat T1 and the protective resistor R1 from the effects of high impedance short circuits in the high voltage output.

Pilot light I3 glows with F2 blown, and T1 set for more than 60 volts output.

In reversible polarity units, Models 203 and 206, with or without special features, a "(+)-(-)" METER POLARITY SELECTOR switch, S5, is employed to reverse the dc meter polarity. In Fig. (2) this is shown for a standard design as double pole. In Fig. 3, it is shown as four pole, as, in the -M designs, the kilovoltmeter and the load current meter must both be reversed.

II: Models with SPECIAL FEATURES:

Figure 3 shows the most complicated design possible in this series, the Model 206-OL1-F-M2-V2, and includes all the added controls required for the various features, as discussed below:

-F designs:

Referring to Fig. 3: a step-down transformer, T4, of approximately 50/1 ratio, applies approximately 2 volts across the potentiometer R11, the FINE HIGH VOLTAGE CONTROL. The input to the high voltage transformer T3 is in series with the tapped part of R11. Therefore, a signal of 0-2 volts, approximately, can either be added to, or subtracted from, the output of T1, (once T1 is set). This represents about 1/50 or 2% of the maximum output voltage, or 600 volts dc output. Since R11 can be set to about 1 part in 40, the fine control can add or subtract 1/2000 part, or 0.05%, which is 15 volts. (Such fine control is warranted, generally speaking, only if the dual range kilovoltmeter feature, -V2, discussed below, is employed, and a line voltage stabilizer is used.)

-M2 designs:

A load current meter range selector switch, S7, "200-2000 MICROAMPERES", is employed to change the OUTPUT CURRENT meter sensitivity. The meter circuit operation is discussed below, in the HIGH VOLTAGE CIRCUITS section.

-OL and -OL1 designs:

There is an overload relay K3 (required in both designs) that pulls in when an overload occurs (discussed later, under the HIGH VOLTAGE CIRCUITS section.) This closes contacts 3a, energizing relay K2, (required for both designs) and opening contacts 2a. When these latter contacts open, primary power is removed from covat T2 and from the high voltage transformer.

The "holding contacts" 2b on K2 ensure that K2 will remain energized, and I4, OVERLOAD, be illuminated following the overload, even though the overload condition has been eliminated by the opening of contacts 2a, with the consequent removal of high voltage power.

When the OVERLOAD RESET pushbutton S6, (used in both designs) is depressed, K2 is de-energized, and the system reset for operation.

In the -OL1 design, the OVERLOAD TRIP CONTROL rheostat R9 is employed to vary the trip point of the overload relay K3. Fig. 4 is a typical overload relay calibration curve. (Due to variations of relays' characteristics, the curve may be in error by 20% for any particular power supply.)

-V2 designs:

A kilovoltmeter range selector switch, S8, "10-30 KILOVOLTS", is employed to change the OUTPUT VOLTAGE meter sensitivity. The meter circuit operation is discussed below, in the HIGH VOLTAGE CIRCUITS section.

(b) HIGH VOLTAGE CIRCUITS:

I: Basic circuits, All models.
1: Models 201, 204:

Referring to Fig. 1:

The high voltage doubling circuit consists of transformer T3, capacitors C3 and C4, and rectifiers V1 and V2, connected as a full wave voltage doubler**, for positive high voltage polarity.

R1 is a protective resistor to limit the value of the initial surge of current in the output circuit, in case of arc-over or failure of a component subjected to the high voltage. (See Application Note No. 6, page 10).

R2 acts a bleeder across the high voltage capacitors, and as the voltmeter multiplier. Meter M2, OUTPUT VOLTAGE, serves as the output voltage indicating meter. R3 calibrates M2 for full-scale deflection with 30 kv dc output.

It should be noted that the output kilovoltmeter is connected directly at the output lead; therefore no correction need be made to the kilovoltmeter reading for the IR drop across the protective resistor R1.

2: Models 202, 205:

The high voltage circuit is identical to that discussed above, except that rectifiers V1 and V2 are reversed in sense, producing high voltage negative with respect to ground (or positive) case. This is shown in Fig. 1.

3: Models 203, 206:

Output voltage polarity reversal is effected by interchanging the plate connection of V2 and the cathode connection of V1 in the high voltage circuit, as shown in Fig. 2. In the schematic diagram, the crossed lines (++) represent the connections for positive high voltage polarity, and the dashed lines (--) the connections for negative high voltage polarity.

Switch S5 METER POLARITY SELECTOR, is a double pole, double throw rotary snap switch that reverses the polarity of the output voltage indicating meter M2, to correspond to the high voltage polarity in use.

II: SPECIAL FEATURES:

(1) -M1 and -M2 designs:

In the -M units, a dc load current meter is placed in the ground return lead of the high voltage rectifiers' circuit, as shown in Fig. 3. (This is M1, labelled OUTPUT CURRENT, replacing the covat current meter). In this connection the meter will read the average dc load current; since no average dc can flow from capacitors C3 and C4 at the steady state, the dc load MUST be flowing through the rectifiers. With this connection, the load current meter M1 indicates all of the corona current and leakage current in the power supply as well as the actual load current.

In order to protect the meter against surges in case of load failure, a resistor R4 is included in series with the meter, with a neon glow lamp I5 across the combination. I5 fires when the load current exceeds approximately 1.5 times the full scale reading of the meter, and any increase in current will flow through the neon lamp, thus protecting the meter. Capacitor C5 ensures firing of I5 on average current, rather than on the peak rectifier currents that flow.

NOTE: The return of M2, OUTPUT VOLTAGE, is not to ground, but to the high end of M1, so that the load current meter does not register the kilovoltmeter current. This connection introduces a kilovoltmeter error of approximately 50 volts at 2 ma load. This is negligible in almost all applications of the series 201 units, and is well below the readable limit of the meter scale.

R5 calibrates M1 for 2000 microamperes full-scale reading.

The M2 designs have a 2-range output current meter, 200 and 2000 microamperes dc full scale. With this design, a load current of 5 microamperes can be measured, so that at 30,000 volts, direct

$\frac{E}{I} = R$ measurements of resistance to 6×10^9

ohms, or 6,000 megohms, can be made without the use of external microammeters.

The basic movement of M1 is 150 microamperes so that the single pole toggle switch S7, OUTPUT CURRENT METER RANGE, is needed to throw in the additional shunting resistor R6, in the "200" position.

(2) -OL designs:

Referring to Fig. 3:

A dc relay, K3, is inserted in the ground return circuit of the high voltage rectifiers. This relay is set to pull in at approximately 1.8 ma total load current through the rectifiers. Capacitor C5, a filter capacitor, ensures that K3 will respond to average load current, rather than to the large peak currents that flow through the rectifiers.

When K3 pulls in due to an overload, contacts 3a in series with K2 close, causing K2 to pull in, opening contacts 2a and removing filament as well as high voltage transformer primary power, as discussed previously, under CONTROL CIRCUITS, II, page 5.

(3) -OL1 designs:

In the -OL1 models, the overload relay K3 pull-in current is adjustable by means of rheostat R9, OVERLOAD TRIP CONTROL.

(4) -V2 designs:

referring to Fig. 3:

Resistor R8 is added for calibration on the 10 kv range, and switch S8 "10-30 KILOVOLTS" added to select the range.

Resistor R7 is added to prevent "overdamping" on the 30 kv range.

Neon lamp I6 protects M2 against overloads in case S8 is set on the wrong range.

OPERATING INSTRUCTIONS

(ALL MODELS)

1: GROUND THE POWER SUPPLY BY MEANS OF THE BINDING POST PROVIDED FOR THIS PURPOSE, ON THE LEFT SIDE OF THE CABINET (AS VIEWED FROM THE FRONT).

2: POLARITY REVERSAL: (Models 203 and 206) Two wires as shown heavily in the rear view of the power supply Fig. 5, must be properly placed for positive or negative high voltage. These two wires terminate in banana plugs, and are put into suitable jacks connected to ground and the high voltage capacitor C4.

(a) POSITIVE HIGH VOLTAGE (negative ground):
The two wires must be connected as shown solid, in Fig. 5.

i.e. (1) From the plate cap of V2 to the ground, or right, jack J4.

(2) From the cathode of V1 to the high voltage, or left, jack J5.

(b) NEGATIVE HIGH VOLTAGE (positive ground):
The two wires must be connected as shown by the broken lines in Fig. 5.

i.e. (1) From the plate cap of V2 to the high voltage, or center, jack J5.

(2) From the cathode of V1 to the ground, or right, jack J4.

3: Connect the line cord to a nominal 117 volt, 50 or 60 cycle outlet, and plug into the recessed receptacle on the lower left hand side. This will simultaneously energize the two-pronged outlet, on the cabinet side, which may then be used for any auxiliary equipment up to 10 amperes, 117 volts ac rating. Connect the output cable to the load.

4: Throw the FILAMENTS ON toggle switch to ON. This energizes the rectifier filaments, and illuminates the FILAMENTS ON pilot light. A warm-up time of 1 second is adequate, as the rectifier cathodes are directly heated.

5: TURN THE "HIGH VOLTAGE CONTROL" TO ZERO (Recommended, not mandatory). See PRECAUTIONS 3, page 8.

6: (-OL1 designs only): Set the OVERLOAD TRIP CONTROL to the setting corresponding to the desired trip current. See Fig. 4 for the approximate calibration.

7: Depress the HIGH VOLTAGE HOLD pushbutton. This energizes the covat* and illuminates the HIGH VOLTAGE ON pilot light. Turn the covat control clockwise and read the output voltage on the output voltage meter.

8: TO MAINTAIN HIGH VOLTAGE WITHOUT HAVING TO KEEP THE "HIGH VOLTAGE HOLD" pushbutton depressed; proceed as in step (7). When the HIGH VOLTAGE HOLD button has been depressed, hold it in, and depress the HIGH VOLTAGE LOCK button. Both switches may now be released, and the high voltage control manipulated to yield the desired output voltage.

NOTE: In -M1, -M2 and -V2 designs, both meters are protected against overloads on ALL Ranges.

9: TO DE-ENERGIZE THE HIGH VOLTAGE WHEN THE CONTROLS ARE LOCKED IN, depress the HIGH VOLTAGE OFF red pushbutton.

10: Throw the toggle switch to OFF, after de-energizing the high voltage, to turn off permanently.

11: To reset after an overload: (-OL designs)
(a) Remedy the cause of the overload.
(b) Depress the OVERLOAD RESET pushbutton.
(c) Proceed as in steps (5) through (8) above.

PRECAUTIONS

1: ALWAYS OPERATE WITH A GOOD EXTERNAL GROUND. Make this connection before energizing the power supply. For convenience, a terminal post connected to the case is provided at the lower left side of the case.

This precaution will prevent high voltage from appearing on the cabinet unexpectedly, in case of load or component failure.

2: NEVER HANDLE THE OUTPUT LEAD WITH VOLTAGE ON. With normal usage (i.e., a resistive load, or low stored-energy load), this power supply represents no greater hazard to personnel than any household appliance or radio. This is so EVEN IF DIRECT CONTACT IS MADE TO THE 0.005 ufd CAPACITOR* inside the power supply, beyond the protective resistor.

Although a protective resistor is included in the output circuit to limit the short circuit current to a harmless value, nevertheless, an extremely unpleasant shock may be experienced if contact is made with the exposed end of the output lead.

It is suggested that the output clip be connected to the ground post after use of the power supply.

If the load has capacitance more than 0.005 ufd, then great precautions must be taken to avoid contact with the load at voltages above 10 kv.

3: TURN THE "HIGH VOLTAGE CONTROL" TO ZERO AFTER USE and before turning ON. This precaution will obviate the possibility of unexpected high voltage appearing in circuits, and possibly injuring external equipment when the power supply is again turned on.

However, application of full high voltage suddenly will not injure the power supply. (See Application Note No. 6).

4: IF THE OUTPUT DOES NOT REACH 30 KV AT NO LOAD, (MODELS 203 and 206 ONLY), REMOVE THE LINE CORD, and check that the high voltage reversing leads are properly inserted for either positive or negative high voltage, as required.

5: DO NOT DRAW MORE THAN 2 MA DC from the power supply, at ANY output voltage.

The rectifiers are rated at 2 ma dc maximum average current; drawing more current will shorten the life of the tubes noticeably. Since the rectifiers are connected to a full wave doubling circuit, each rectifier has the full average load current flowing through it, not 1/2 the load current, as in an ordinary full wave rectifier circuit.

6: WITH LINE VOLTAGE LESS THAN 100 VOLTS, do not operate at voltages above 10 kv and currents above 1 ma simultaneously. The decreased rectifier cathode voltage at low line voltage will result in excessive tube drop and deterioration of the cathode. At light loads, less than 250 microamperes, the output voltage may be 30 kv with 100 volts input.

7: DO NOT OPERATE WITH LINE VOLTAGE MORE THAN 130 VOLTS for extended periods of time, as rectifier tube life will be shortened noticeably.

APPLICATION NOTES

1: REMOTE OPERATION:

To operate the power supply at a distance from the control panel, remove the panel from the cabinet by unscrewing the six self-tapping holding screws on the panel. (The line cord should be unplugged.) Disconnect the cable connectors that connect the components on the panel to the components in the cabinet proper. Mount the panel as required in the new control position.

Wire a cable of suitable length with a suitable male cable connector at one end, and a corresponding female on the other. The maximum permissible length of the cable is determined by the acceptable additional regulation due to line drop. Since the maximum line current is approximately 1.5 amperes, a typical multiconductor cable of 7 conductors, with No. 20 wire, will result in less than 10% additional regulation for a length of 300 feet.

The panel is interconnected with the cabinet by means of a common grounding wire in the cable. Therefore, if the cabinet is properly grounded, the panel need not be grounded separately. However, taking the additional precaution of separately grounding ALL exposed metal surfaces not mechanically bonded is very good practice when working with high voltage.

2: SAFETY INTERLOCK:

Where the high voltage is being used in conjunction with a high voltage test jig it is frequently desired to interlock the jig cover and power supply, so that the high voltage cannot be applied unless the jig cover is closed. The auxiliary outlet J2 can be readily adopted for external interlocking purposes.

(I) Controlling High Voltage Excitation by External Safety Interlock:

This arrangement of J2 permits relay K1 to remain actuated when the interlock is open. Thus, once the high voltage has been locked in, the output will be controlled by the jig interlock. When the sample under test is put in place, and the jig cover closed, the high voltage will come on automatically when the jig cover closes the microswitch (or other interlocking switch). The high voltage is automatically removed (though not shorted) when the jig cover is opened.

It should be recognized that this method of testing is somewhat hazardous as no automatic output shorting is used. The natural decay rate of the output voltage has a time constant of approximately 1 second. Thus, after 2 seconds, the output voltage is still about 10% of the initial voltage. If the initial voltage is above 15 kv, the residual charge is sufficient to produce a noticeable, though very mild, shock. With no external capacitance, the power supply is essentially fully discharged after 6 seconds maximum.

Referring to Fig. 1, if J2 is disconnected from J1 and placed in series with the short strip of wire running from S3 to the HIGH VOLTAGE ON pilot light I2, the relay will be energized, but the covat will not be energized unless an external short is placed across J2. This short can consist of a microswitch actuated by closing the cover of the test jig, or by a similar device.

To effect change: (Refer to the detailed wiring diagram, Fig. 6, and the panel layout drawing, Fig. 5.)

(a) Remove the front and rear panels.
(b) Loosen the four screws that hold the filament transformer to the cabinet base.

(c) Remove completely the two wires (3) and (4), running from J1 to J2.
(d) Run wires from the lugs of J2 to pins (9) and (10) on the female cable connector.
(e) On the control panel, disconnect the two ends of the wire coded with "Quik-Label" No. 8. This wire runs from the lower right lug on S4, the HIGH VOLTAGE LOCK pushbutton, to the lower lug on I2, the HIGH VOLTAGE ON pilot light (See Fig. 6). Tape up loose ends.
(f) Run a wire from pin (9) on the male cable connector to that lug on S4 from which wire No. 8 was removed, the lug to which wires Nos. 6 and 7 go.
(g) Run a wire from pin (10) on the male cable connector to that lug on I2 from which wire No. 8 was removed, the lug to which wire No. 9 goes. Tape up the loose ends of wire No. 8.
(h) Screw the filament transformer back into place; replace the cable connector cover and plug in the two connectors. Replace the control panel and the rear panel. J2 has now been wired in series with the parallel combination of the HIGH VOLTAGE ON pilot light I2 and the covat primary. Unless J2 is shorted, I2 will not shine when S3, HIGH VOLTAGE HOLD, is depressed.

(II) Controlling Holding Relay with External Safety Interlock:

If it is desired to "unlock" the high voltage when the external interlock is opened, then follow steps (a) through (d) listed above.

Then:

(e) Remove the wire with the Code No. 4. This wire goes from the lower right lug of S3, the HIGH VOLTAGE HOLD pushbutton, to the lower right lug of S2, the HIGH VOLTAGE OFF pushbutton.

(f) Run a wire to S3, from pin (9).
(g) Run a wire to S2, from pin (10).

With this connection, the interlock is in series with the pushbuttons S3 and S2, and unless the external interlock is closed, no power can be applied to the relay or the high voltage circuits. If the relay has previously been "locked in", opening a jig cover interlock will automatically cause the relay to drop out, requiring deliberate resetting of the two pushbuttons S3 and S4 with the interlock closed, before high voltage can again be attained.

3: AUTOMATIC OUTPUT SHORTING: or EXTERNAL "HIGH VOLTAGE ON" SIGNAL:

J2 can be used to energize an automatic output voltage shorting mechanism or external alarm. Thus, if J2 were connected in parallel with I2, line voltage would appear at J2 when high voltage is on, and would be removed when high voltage is off.

This power could actuate a solenoid that removes a short from the output or could energize an external HIGH VOLTAGE ON light, etc. When the power is removed from the solenoid, the solenoid plunger dropping out can short the output, bringing the high voltage dc inside the power supply and across the test specimen, rapidly to zero.

To connect J2 for such operation, it is necessary to move the lead, shown in Fig. 1 as going from the top of J2 to the top of J1, to the upper side of the covat input or I2. To effect this change (refer to the appropriate detailed wiring diagram, Fig. 6 and the corresponding layout diagram, Fig. 5).

(a) Remove the front and rear panels.
(b) Loosen the four screws that hold the filament transformer to the cabinet base.
(c) Remove complete wire No. 3 going from J2 to J1.
(d) Run a wire from the now vacant lug on J2 to pin (9) of the female cable connector.
(e) Run a wire from pin (9) of the male cable connector to that lug on the HIGH VOLTAGE ON pilot light I2 that has the wire with code No. 8, the LOWER pilot light lug.
(f) Follow instructions (h) on this page.

Now, when the primary of the covat is energized, J2 will also be energized with line voltage. Thus, power is available to operate a solenoid or other mechanism that automatically shorts out high voltage when the HIGH VOLTAGE OFF pushbutton, S2, is depressed, or when S3, the HIGH VOLTAGE HOLD pushbutton, is released. It can light a warning lamp, etc.

4: KILOVOLTMETER ACCURACY:

The initial accuracy of the kilovoltmeter is better than 2.5% of full scale over the entire kilovoltmeter range. The kilovoltmeter multiplier has an inherent temperature coefficient that will cause a drift of indication equal to approximately 1.5 kv, if the output is maintained at 30 kv continuously.

At output voltages below 24 kv, the heating effect on the multiplier is almost negligible. Therefore, at voltages below 24 kv the output kilovoltmeter indication may be taken as quite accurate. For more accurate readings above 24 kv, if the power supply is operated continuously at the high voltage, a precision kilovoltmeter, such as the Beta Electric Corp. Model 142, should be connected across the output. An alternative is to apply a correction of approximately 1.5 kv to the reading at 30 kv. The power supply kilovoltmeter will read high, so subtract the correction from the reading.

5: CAPACITOR TESTING:

If the series 201 power supply is used for testing capacitors for high voltage breakdown, and if the full high voltage is applied suddenly, the life of the high voltage rectifiers may be noticeably shortened by the repeated large surges of doubler capacitor charging current that will flow each time the high voltage is turned on.

To eliminate this effect, resistance should be put in series with the covat primary, to lower the initial voltage available at the input to the high voltage transformer. A resistor of 20 ohms will not drop the steady-state voltage noticeably if the capacitor under test is good, and yet will reduce the starting surge current through the rectifiers by as much as 75%. In addition, if the capacitor under test fails, the steady-state current through the tubes will be limited to a safe value for short-time tests.

The 20 ohm resistor should be rated for at least 20 watts and should be mounted on the control panel in series with wire No. 9, that connects to the HIGH end of the covat input. See Fig. 5.

6: LOAD SURGE CURRENT LIMITATIONS:

As discussed on page 6, resistor R1 is included in the output circuit to limit the surge current available from the capacitors C3 and C4, in case of load failure or flashover. However, the initial instantaneous current is determined (in case of NON-CAPACITIVE LOAD ONLY) by the value of the capacitance of the output cable. This is approximately 180 mmf., and discharges in a matter of microseconds under normal flashover conditions. The instantaneous current can be very large, being determined by the flashover arc characteristics, although the energy in the cable is quite low.

If the large instantaneous current is not desired, then a surge suppressing resistor must be connected directly at the load, between the output cable connector and the load input terminal. The resistor must be designed to withstand 30 kv surges; it is recommended that a type similar to R1 be used.

With this type of protective resistor connection, the load current must be measured, and an IR drop correction be made to the kilovoltmeter reading, for accurate indication of the voltage applied TO THE LOAD.

* * * * * *

SERVICE NOTES

In addition to the printed diagrams, Figs. 1, 2, 3, 4, and 5 referred to in the text, there is included in each manual a drawing corresponding to the detailed point-to-point low voltage wiring, Fig. 6. These are provided for general servicing and trouble shooting.

1: NO OUTPUT VOLTAGE READING:

A: Low covat current or load current meter indications:

If either of these meters reads low, and there is no high voltage output, the possibility of a short in the high voltage circuit is eliminated.

I: Check that the output voltage meter is not open or shorted, by testing the power supply output with a Beta Electric Corp. Model 102 or 121 kilovoltmeter, 0-30 kv dc scale. If such a meter or similar instrument is not available, check by means of drawing a spark from the high voltage lead to ground.

II: Check the rectifiers, to see that the filaments are lit. If the filaments are on, replace the tubes, as the rectifiers may have lost emission.

III: If rectifiers are satisfactory, check for open leads in the high voltage circuit.

IV: If the high voltage circuit shows continuity, measure the output voltage of the high voltage transformer by means of a suitable multitester on the 5,000 volts ac range.

CAUTION: DO NOT TOUCH THE METER DURING THESE TESTS AS THE SECONDARY OF THE TRANSFORMER IS NOT GROUNDED.

If no output voltage from the ac transformer is indicated on this test, check the primary circuits for an opening in the leads going from the control circuit and the control panel to the primary of the high voltage transformer, or for an open primary in T3.

B: Low or no output voltage, with large reading of covat current meter or load current meter.

This indicates a short or partial short in the high voltage circuit. Check as follows:

I: Examine the rectifiers. If both filaments are lit, then turn the output up somewhat and see if a blue glow appears in any tube. A blue glow is indicative of a gassy rectifier, which will cause a short circuit in these high voltage circuits. Replace any gassy rectifier.

If one or both of the rectifiers has a dark filament, then the filament may be burned out and shorted to the plate. Replace the rectifier and recheck operation.

II: If the rectifiers are satisfactory, then the next possible source of difficulty is a shorted capacitor. Remove the transformer's secondary lead that goes to the smaller standoff insulator of the high voltage capacitor. Repeat the tests. If the high covat current condition is removed, then the capacitor has failed and must be replaced. If the high current condition still exists, then the fault is in the high voltage transformer, and it must be replaced.

C: Other types of failures, such as open multiplier resistor, open protective resistor, or open high voltage lead, will be indicated by erratic readings on the high voltage meter M2.

2: HIGH VOLTAGE LOCK RELAY NOT PULLING IN:

If dirt accumulates on either contacts 1a or 1b, relay K1 may not pull in when the pushbuttons are depressed. Dirt can readily be removed from the contacts by running a fine emery cloth across the contacts. From Fig. 5, the location of the relay can be seen, and from Fig. 6 can be determined the lead numbers going to the contacts that have to be cleaned.

3: CONTROL CIRCUIT FAILURES:

The operation of various control elements is straight forward, and failure of any elements should be readily detected. The basic circuit diagrams, the detailed wiring diagram, Fig. 6, and the detailed layout diagram, Fig. 5, should simplify all trouble shooting.

* * * * * * * *

The 2 references below apply respectively to the HIGH VOLTAGE CIRCUITS section, page 6, item b, left hand column, and the PRECAUTIONS section, page 7, item 2.

** D. L. Waidelich, "The Full Wave Voltage Doubling Rectifier Circuit," Proc. of I. R. E., Oct., 1941, pp. 554-558, incl.

*Prof. C. F. Dalziel, "A Study of the Hazards of Impulse Currents," A. I. E. E. Transactions, Oct., 1953, pp. 1032-1043, incl.

PARTS LIST

For Models 201, 202, 203, 204, 205
206 and F, M1, M2, -OL, -OL1, /R, V2 Designs

PORTABLE 0-30,000 VOLTS DC POWER SUPPLIES

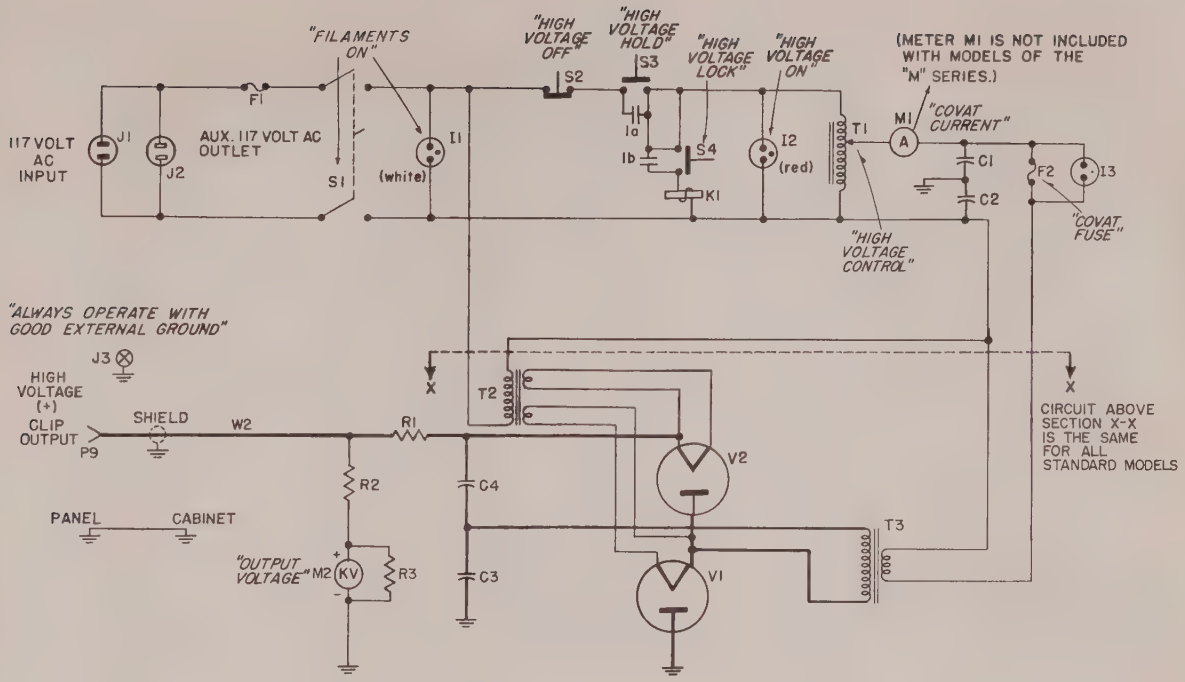
PART DESIGNATION		
On Circuit Diagram (Fig. 6)	Not on Circuit Diagram	DESCRIPTION
	A1	Cabinet and rear panel; Beta dwg. β -c-201-A2.
	A2	Control panel; Beta dwg. β -b-201-A1.
	A3 a,b	Lucite pieces for tube and resistor shelf; Beta dwg. β -b-201-A4.
	A4 (/R designs only)	Relay rack panel; Beta dwg. β -c-201-A3.
	A5 a,b	Lucite corona shield pieces per dwg. β-b-201-A6.
	A5 c (Models 204, 205, 206 only).	Lucite cabinet top flash barrier piece per dwg β -b-201-A6.
C1,2		Paper molded capacitor, 0.01 mfd, 400 V dc; Micamold No. 339-BR110 or equivalent.
C3,4		Single can, dual section capacitor; 0.01-0.01 mfd, 16 kv dc per section; Beta No. 20123.
C5,6		0.25 mfd, 400 V dc paper; Cornell Dubilier Tiny Chief or equivalent.
	E1,2	Anti-corona tube socket shield, Beta dwg. β -a-ACS-1.
	E3	Strain relief bushing, for output cable; Heyman Manufacturing Co. No. SR-7P.
	E4	Red flexible insulator, for output clip; Mueller No. 29 or equivalent.
	E5	Red cap for pushbutton S2, Arrow-Hart and Hegeman No. 3391-194.
	E6,7	Black cap for pushbutton S3, S4, Arrow-Hart and Hegeman No. 3391-194.
	E8 (Types 203, 206)	1-1/4" pointed black bakelite knob, 1/4" shaft, brass insert; ICA No. 1274S or equivalent.
	E9 (-F designs only)	Per above.
	E10 (-M2 designs only).	Per above.
	E11 (-OL1 designs only).	Per above.
	E12 (-V2 designs only).	Per above.
F1		2 amperes, 125 volts ac fuse; Littelfuse type 3AG or equivalent.
F2		1 ampere, 125 volts ac fuse; Littlefuse type 3AG or equivalent.
I1,2,3,4,5,6		Neon bulb, NE-51, 115 volts ac, 1/25 watt, miniature bayonet, T-3-1/4.
J1		2 pole standard plug, recessed male receptacle, 110 v, 15 a; 250 v, 10 a; Amphenol No. 61-M10.
J2		2 pole universal flush female receptacle; 110 v, 15 a; 250 v, 10 a; Amphenol No. 61F1.
J3		Vise grip ground binding post; ICA No. 631 or equivalent.

PART DESIGNATION		DESCRIPTION
On Circuit Diagram (Fig. 6)	Not on Circuit Diagram	
J4,5 (Types 203, 206)		Banana jack; Birnbach No. 403
J6		10 prong Jones socket, No. S-310-CCT.
K1,2		D.P.-D.T. relay; 117 v ac, 60 cycle coil; 3 amperes, 115 volt ac contacts; Potter-Brumfield KR11A.
K3		1/2 milliampere dc; 12,000 ohm coil; S.P.-D.T.; 110 volt ac contacts; Kurman type BK35.
M1 (standard designs)		0-1 ampere ac; 2-1/2" round flush bakelite case; Simpson Electric Co. Model 155.
OR M1 (-M1 designs only)		0-150 microamperes dc sensitivity; dial labelled 0-2 MILLIAMPERES DC; 2-1/2" round flush bakelite case; Simpson Electric Co. Model 125.
OR M1 (-M2 designs only).		0-150 microamperes dc sensitivity; dial labelled 0-200/2000 MICROAMPERES DC; 2-1/2" round flush bakelite case; Simpson Electric Co. Model 125.
M2 (standard designs)		0-150 microamperes dc; dial labelled 0-30 KILOVOLTS DC; 2-1/2" round flush bakelite case; Simpson Electric Co. Model 125.
OR M2 (-V2 designs only).		0-50 microamperes dc; dial labelled 0-10/30 KILOVOLTS DC; 2-1/2" round flush bakelite case; Simpson Electric Co. Model 125.
	P1	On W1.
P2,3	NOT SUPPLIED.	
P4,5 (Types 203, 206, only).		Banana plug, Birnbach No. 401.
P6		10 prong Jones plug No. P-310-CCT.
	P7,8 (Types 201, 202,203 only).	3/8" steatite tube cap; National SPP-3 or equivalent.
	P7,8 (Types 204, 205,206, only).	9/16" steatite tube cap; National SPP-9 or equivalent.
P9		Mueller clip No. 27.
R1		1/2 megohm, 15% tolerance; Resistance Products Co. type BFQ.
R2		180 megohms, 10% tolerance; Resistance Products Co. type BFW.
R3 (standard designs)		Wire wound or metallized calibrating resistor for M2 meter; approximately_____ohms.*
OR R3 (-V2 designs)		Wire wound or metallized calibrating resistor for kv meter; 30 kv range, approximately 1/4 megohms.
R4		250k ohms, 1/2 watt, metallized.**
R5		Wire wound or metallized calibrating resistor for M1 on 2000 ua range; approximately 20K ohms.**
R6		Wire wound or metallized calibrating resistor on 200 ua range; approximately 200K ohms.**
R7		650k ohms, 1/2 watt, metallized.*
R8		Calibrating resistor for 10 kv range; approximately 1 megohm; 1/2 watt, metallized.*

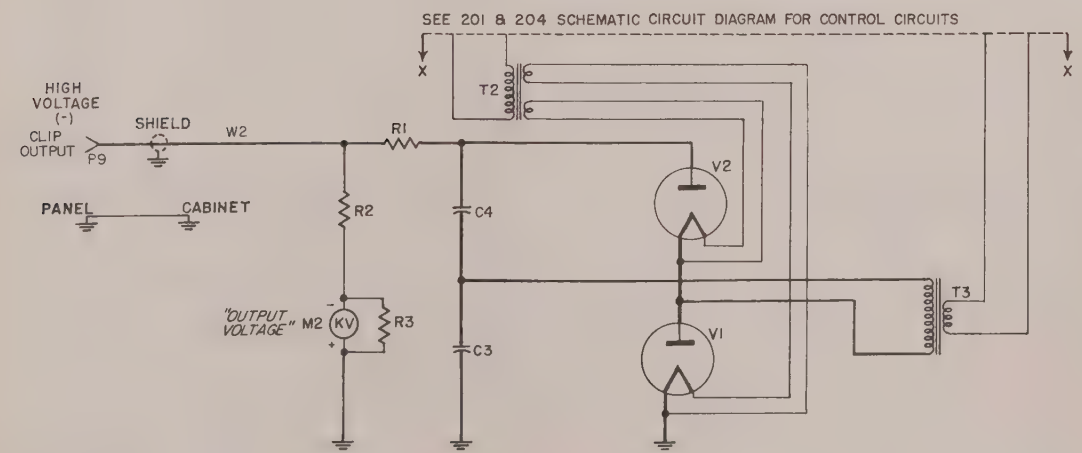
PART DESIGNATION		DESCRIPTION
On Circuit Diagram (Fig. 6)	Not on Circuit Diagram	
R9		Wire wound potentiometer, 100k ohms, 3 watts, Clarostat No. A10-100K, or equivalent.
R10		Wire wound or metallized resistor, approximately 100K ohms, 1/2 watt.
R11		3 ohms, 4 watts, wire wound Mallory M3R, or equivalent.
S1		Toggle switch, D.P.-S.T., 3 amperes, 125 volts ac; screw terminals; Arrow-Hart & Hegeman No. 8965 or equivalent.
S2,3,4		Momentary pushbutton switch, 2 circuits; 1NO, 1NC; BREAK BEFORE MAKE; 3 amperes at 125 volts ac contacts with screw terminals; Arrow-Hart & Hegeman No. 3392A or equivalent.
S5 (Types 203, 206 only)		Rotary snap switch; D.P.-D.T., 3 amperes, 125 volts ac; with screw terminals; Arrow-Hart & Hegeman No. 1575 or equivalent.
OR S5 (-M designs, Types 203,206 only)		4 pole, 2 position, shorting type, rotary selector switch; ceramic; Centralab No. 1408.
S6		Momentary pushbutton switch, 2 circuits; 1NO, 1NC; BREAK BEFORE MAKE; 3 amperes at 125 volts ac contacts with screw terminals; Arrow-Hart & Hegeman No. 3392A or equivalent.
S7,8		Rotary snap switch; D.P.-D.T., 3 amperes, 125 volts ac; with screw terminals, Arrow-Hart & Hegeman No. 1575 or equivalent.
T1		Covat*, 115/0-135 volts, 1.5 amperes, Superior Electric Co. type 10 Powerstat.
T2		117 volts primary; Secondary: 2 windings; each 1.3 volts at 0.3 amperes, or 1.6 volts at 1.25 amperes; or 2.6 volts at 5 amperes (by means of PRIMARY taps.) Each winding insulated for 30 kv dc in air. 45 kv dc potted; Beta No. 20115.
T3		117/11,500 volts at 4 ma; start of secondary insulated for 16 kv dc; Beta No. 20113; air insulated.
T4		117/2.5V, 1.5A; Stancor No. P-4026 filament transformer.
V1,2 (Types 201, 202,203) OR V1,2 (Types 204, 205,206)		1B3 rectifier tube. 5825 rectifier tube.
	W1	Line cord, 6' long, Cornish Wire Co. No. 1462 or equiv.
W2		RG 8/U cable, 6' long.
	XF1,2	Fuse holder assembly, Bussman type HKP.
	XI1,2,3	Neon pilot light assembly, clear faceted lens, DIALCO No. 811308-437.
	X14,5,6	Neon pilot light assembly, DIALCO No. 4931-L-3.

* Any of these may have to be changed if M2, or any of R2, R3, R8 or R9 is changed.
**Any of these may have to be changed if M1, or any of R5, R6, or R7 is changed.
* COVAT - - COntinuously Variable Auto Transformer; i.e., powerstat, variac, etc.

PART DESIGNATION		DESCRIPTION
On Circuit Diagram (Fig. 6)	Not on Circuit Diagram	
	XV1,2 (Types 201,202,203). OR XV1,2 (Types 204,205,206).	Octal breadboard socket, EBY 12-8 (no equivalent). 4 prong breadboard socket, EBY 12-4 (no equivalent.)
	TB1	Jones barrier strips; Cinch Jones No. 2-141.
	TB2	Jones barrier strips; Cinch Jones No. 4-141.
		NAMEPLATES
	NP1 (all units)	ALWAYS OPERATE WITH GOOD EXTERNAL GROUND, (β dwg. No. β-a-NPA-7.)
	NP2 (-F designs only)	COARSE HIGH VOLTAGE CONTROL. (β dwg. β-a-NPA-7.)
	NP3 (-F designs only)	FINE HIGH VOLTAGE CONTROL. (β dwg. β-a-NPA-7.)
	NP4 (-V2 designs only)	FULL SCALE KILOVOLTS 10 30. (β dwg. β-b-NPA-5.)
	NP5 (-M2 designs only)	FULL SCALE MICROAMPERES 200 2000. (β dwg. β-b-NPA-5.)
	NP6 (-R designs only)	METER POLARITY SELECTOR + - . (β dwg. β-a-NPA-7.)
	NP7	NEGATIVE HIGH VOLTAGE POLARITY (POSITIVE GROUNDED) (β dwg. β-a-NPA-7.)
	OR	POSITIVE HIGH VOLTAGE POLARITY (NEGATIVE GROUNDED) (β dwg. β-a-NPA-7).
	OR	REVERSIBLE HIGH VOLTAGE POLARITY (LOW TERMINAL GROUNDED) (β dwg. β-a-NPA-7).
	NP8	OUTPUT CURRENT (β dwg. β-a-NPA-7).
	NP9	OUTPUT VOLTAGE (β dwg. β-a-NPA-7).
	NP10 (-OL1,OL2 designs only)	OVERLOAD (β dwg. β-a-NPA-7).
	NP11 (-OL1,OL2 designs only)	OVERLOAD RESET (β dwg. β-a-NPA-7).
	NP12 (-OL2 designs only)	OVERLOAD TRIP CONTROL (β dwg. β-a-NPA-7).
	NP13 (all units)	BETA ELECTRIC CORP. HIGH VOLTAGE D.C. POWER SUPPLY (β-a-NPA-6).
	NP14 (all units)	BETA ELECTRIC CORP. MODEL No. SERIAL No. (β-a-NPA-6)
	NP15 (-F, -OL2 designs only)	CONTROL 0-10, MALLORY No. 395
	NP16 (all designs)	DANGER H.V. (small aluminum) (β-a-NPA-8).
	NP17 (all designs)	Covat dial (integral with T1 assembly.)

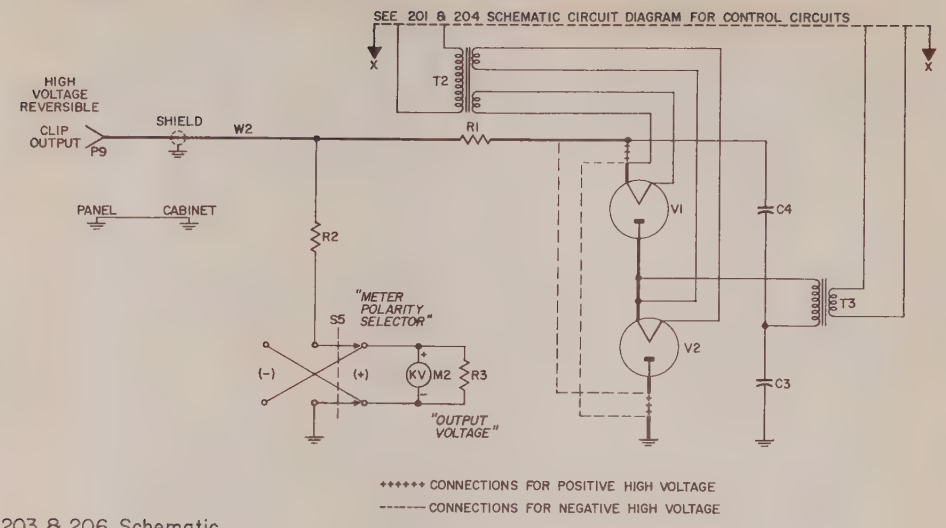


201 & 204 Schematic Circuit Diagram



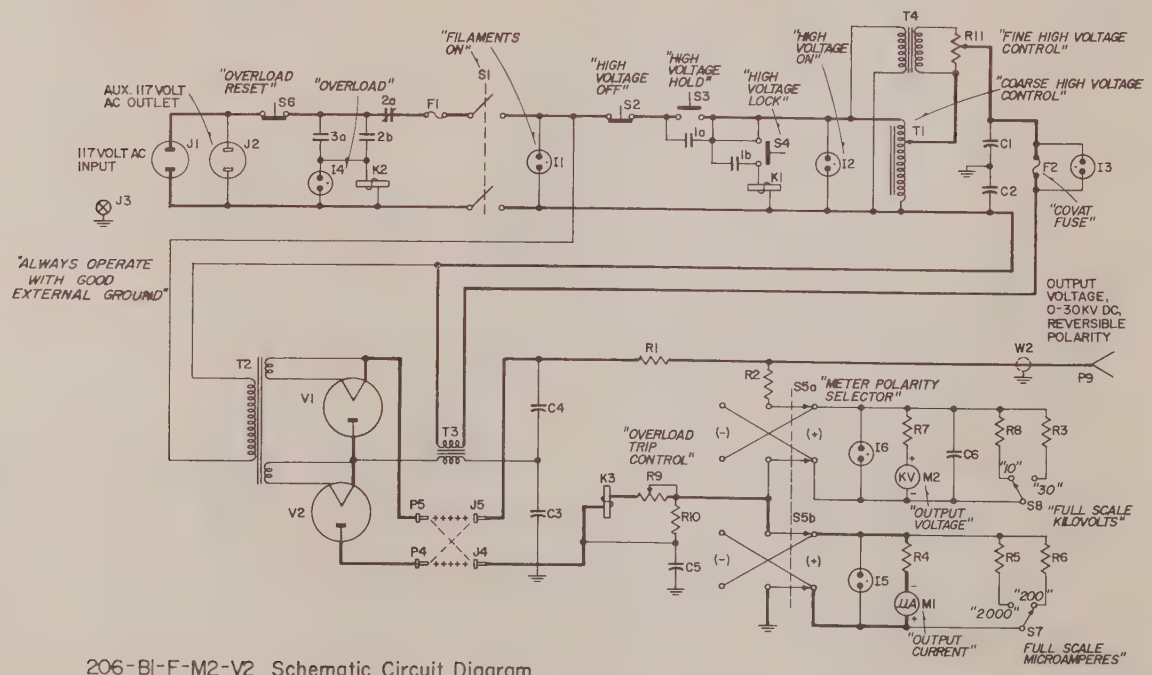
202 & 205 Schematic High Voltage Circuit Diagram

FIGURE 1



203 & 206 Schematic
High Voltage Circuit Diagram

FIGURE 2



206-B1-F-M2-V2 Schematic Circuit Diagram

FIGURE 3

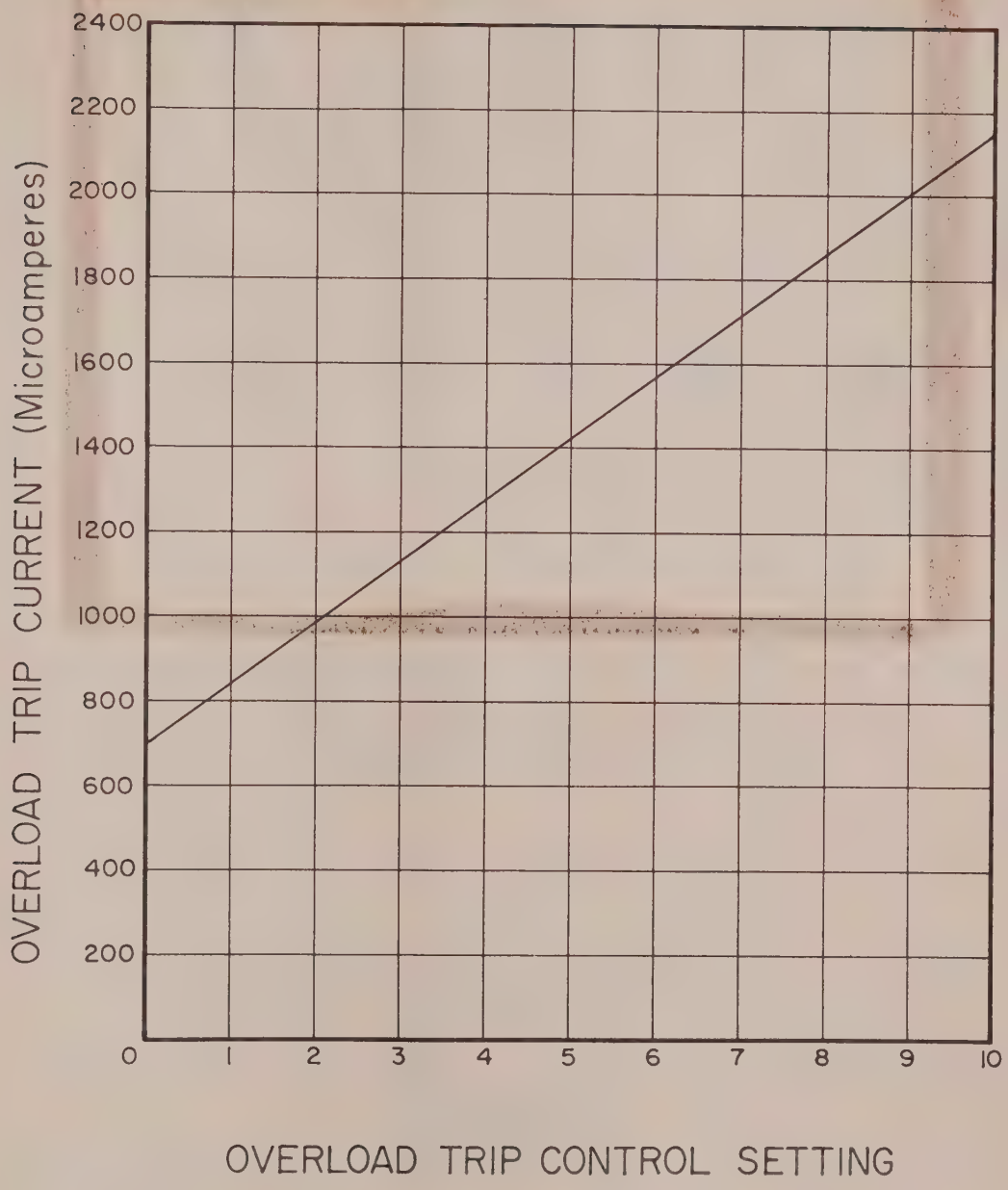
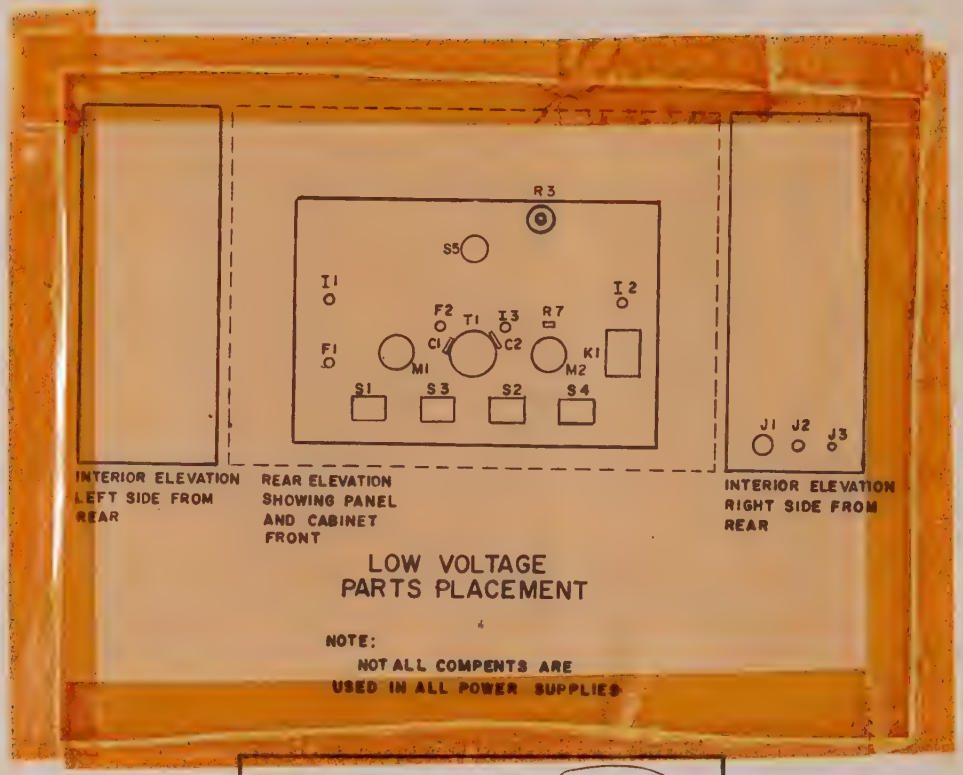
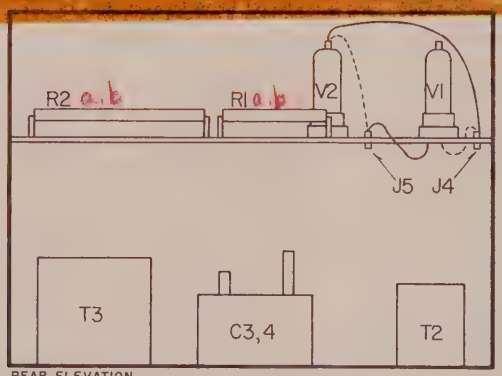

OVERLOAD TRIP CURRENT (Microamperes)
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
OVERLOAD TRIP CONTROL SETTING

FIGURE 4





NOTE:
JACKS ARE USED IN 203 & 206 DESIGNS ONLY. SOLID LINES SHOW CONNECTIONS OF POLARITY REVERSING LEADS FOR HIGH VOLTAGE POSITIVE. DASHED LINES SHOW CONNECTIONS FOR HIGH VOLTAGE NEGATIVE

FIGURE 5

CABINET

PANEL

F1 4 AMPS

S1 S2 S3 S4

I1 I2 I3

1a 1b

K1(b)

M1 0-3 AMPS

F2 3 AMPS

TYPE 20 T1

C1 .01mf 600V

C2 .01mfd 600V

S5

M2 KV

R7 250K RED

R3 500K

GREEN

J1 J2

P6 MALE

J6 FEMALE

J3

R2b 180M BFW

R2a

W2

R1b 0.1M.Ω BFQ

R1a 0.1M.Ω BFQ

TB2 4-141

T2 β # 20115

V1 8013A

V2 8013A

TB1 2-141

T3 β # 20741

C4 .01-.01mfd 16 KV DC

C3

P5 J5

P4 J4

NOTES:

POT WITH MECHANICAL STOP SET FOR MINIMUM RESISTANCE;
APPROXIMATELY 10% OF MAXIMUM.

NO.	REVISION	BY	DATE
1	R1b 0.1M ADDED	FR	1/24/57
2	R12 REMOVED-REPLACED BY	FR	1/24/57
	JUMPER, R13 REMOVED	FR	1/24/57
3	KV CIRCUIT REVISED	SE	3-7-57
4	R7 CHANGED FROM 650K TO 250K	AV	5-17-57
5	FORMERLY 209	AV	5-17-57

SCHEMATIC WIRING DIAGRAM

DIMENSIONS IN INCHES DO NOT SCALE

DRAWN BY FR 2/23/56

CHECKED BY HC 2/24/56

APPR'D BY HC 2/24/56

BETA ELECTRIC CORP.
NEW YORK 29, N. Y.

B 230-5-6
(REVISION 5)

NO.	REVISION	BY	DATE

Model 230-5 PARTS LIST ADDENDA

DATE 5-20-57

TYPED BY: hk

CHECKED BY

APP'D BY

BETA ELECTRIC CORP.

PARTS LIST. PAGE 2

PART NO.	BETA CODE NO. AND DESCRIPTION	LOCATION	FUNCTION
R1a,b	4R 0.1 megohm, RPC type BFQ; 15% tolerance resistor.	Cabinet	Short circuit current limiters.
R2a,b	4R 180 megohm, RPC type BFW, 10% tolerance resistor.	Cabinet	Kilovoltmeter multiplier.
R3	10R 500k potentiometer, wire wound, 1/2 watt.	Panel	Calibrator for M2.
R7	2R 250k, 1/2 watt; Continental-Nobeloy type X-1/2.	Panel	Calibrator for M2.
T1	500T Superior Electric single phase, hand operated powerstat, type 20, 115 V, 3.0 amperes.	Panel	Controls as labelled.
T3	322T 115V, 60 cycle primary; 11.5 kv rms to deliver 30 kv dc at 6 ma dc; from a F.W.V. doubler; hypersil core pri-sec. shield; β# 20741.	Cabinet	Plate transformer.
V1,2	4V type 8013A; 2.5V filament at 5A; average current: 20 ma max; inverse peak: 40 kv.	Cabinet	Rectifiers.

NO.	REVISION	BY	DATE
	Formerly Model 209	hk	5/17

Model 230-5 PARTS LIST ADDENDA

DATE 5-20-57

TYPED BY: hk

CHECKED BY

APP'D BY

BETA ELECTRIC CORP.

PARTS LIST. PAGE 1

PART NO.	BETA CODE NO. AND DESCRIPTION	LOCATION	FUNCTION
A1	3A β-c-3A-200-A1.		Cabinet and rear panel.
A2	22A β-c-22A-200-A2.		Control panel.
A6a,b	Lucite, per β-a-201-A7.	Cabinet	Lucite shield pieces.
B1-6	15Bs Screen, Redmond MTR-105	Cabinet	Ventilation screens.
F1	1F 4 ampere extractor post cartridge fuse; 250V ac rating; Littelfuse type 3AG or equivalent.	Panel	As labelled.
F2	1F 3 amperes, per F1.	Panel	As labelled.
H1	Bracket per β-a-200-H1.	Panel	Potentiometer bracket.
H2-5	73H Rubber feet, 7/8"D with 10-32 x 1/2" stud; Miller Prods. #2102 or equivalent.	Cabinet	Rubber feet.
H6	76H Stanley #482J handle, gray.	Cabinet	Handle.
H7,8	43H Tube clamp; Birtcher #926C.	Cabinet	Tube clamps.
J4,5	62J Jack, nylon tip; E.F. Johnson 105-703, black.	Cabinet	Polarity reversing jacks.
K1	24K 115V, 50/60 cycles coil; DPDT, 3A; P-B KR11A.	Panel	High voltage on holding relay.
M1	8M Simpson Model 155 ac meter; 2-1/2" rd. bakelite case;labelled 0-3 A AC.	Panel	Indicates as labelled.
P4,5	63P E.F. Johnson #105-303; nylon tip plug, black.		Mate with J4,5.

555

Amtite

LIGHT BLUE

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